ATTACHMENT 8: QUALITY ASSURANCE

For the “Attachment Name” in the naming convention of BMS, use “QA” for this attachment.

Demonstrate that appropriate and well-defined Quality Assurance and Quality Control (QA/QC) measures will be used in each task. The information-gained discussion and QA/QC plan in this section should be consistent and incorporated into the project work plan. QA/QC measures may include, but are not limited to the following:

- *Procedural assurances, such as review processes for quality of reports, data, and lab analyses*
- *An existing or proposed QA/QC plan for field sampling and lab analysis of water quality that ensures high accuracy and precision*
- *Personnel qualifications that may include professional registrations (such as a California Professional Geologist or Professional Engineer), certifications, and experience of persons performing and overseeing work to be performed*
- *Standardized methodologies to be used, such as construction standards, health and safety standards, laboratory analysis, or accepted soils classifications methods*
- *Standardized analyses, such as statistical tests or American Society for Testing and Materials and U.S. Environmental Protection Agency analytical methodologies*
- *Quality requirements of material or computational methods, such as use of specific grades of building materials or use of specific, tested, and established models (or software)*
- *Comparison and calibration of models with actual data to enhance accuracy of modeling results*

Squaw Valley Public Service District is committed to ensuring full quality assurance and quality control throughout the project duration. Only by collecting and analyzing data using well established, widely accepted, and defensible means will the District obtain the stakeholder acceptance needed to design and implement future groundwater management activities. Each task has specific QA/QC activities that ensure the task is carried out in a clear, acceptable, and defensible manner.

Task 1: Assessment and Evaluation of Phase I Data

Task 1.1: Quantify Creek/Aquifer Interaction using Depth Specific Temperature Data

Quality assurance and quality control will be assured while analyzing the collected temperature data using the following techniques:

- Contracting Dr. Andy Fisher for senior review and oversight. Dr. Fisher is a highly regarded professor of earth sciences at U.C. Santa Cruz. He is one of the developers of the technique we will use to quantify stream/aquifer interactions. We will draw on his expertise to assist us with analyzing the depth-specific temperature data collected in Squaw Creek. We will have an initial meeting with Dr. Andy Fisher to establish working protocol before any data are analyzed. We will have at least two additional consultations with Dr. Fisher: one during the data filtering and one after the stream/aquifer seepage rates have been calculated. During this last meeting, Dr. Fisher will review all of our assumptions and techniques.
- Using standardized software. The data filtering and seepage calculations will be performed using MATLAB routines. MATLAB is a widely accepted collection of routines developed by MathWorks that perform matrix calculations, numeric computations, advanced graphics and visualization. Using these standardized routines prevents the errors that may result from processing data in spreadsheets or by hand.
- Following the approach in published documents. We will follow the approach published in previous documents including Constantz et al., 2006; Hatch et al., 2006; Sun and Fisher, 1992, and USGS 2004.

Task 1.2: Establish Pumping Impacts on Squaw Creek by Analyzing Aquifer Test Data

Quality assurance and quality control will be assured while analyzing the aquifer test data using the following techniques:

- Using standardized and published aquifer test analyses. We currently plan on analyzing the aquifer test data using the methods developed by Theis (1935), Cooper and Jacob (1946), and Hantush (1955). All of these techniques are well tested, and descriptions of them appear in standard texts such as Kruseman and deRidder (1991).
- Using standardized aquifer test analysis software. Aquifer test data will be analyzed with the Aquifer^{win32} software developed by Environmental Simulations Inc. This widely used and tested software can apply numerous analysis methods to a set of aquifer test data.
- Providing senior review of all techniques and results. All analyses and results will be reviewed by senior hydrogeologists or engineers that are licensed in the State of California. The senior hydrogeologists or engineers will review all analysis techniques, assumptions, and results to make sure the analyses are defensible, accurate, and reasonable.

Task 1.3: Integrate Results from Tasks 1.1 and 1.2 with LLNL Climate Change and Tracer Study

Quality assurance and quality control will be assured while analyzing the LLNL temperature and isotopic tracer data using the following techniques:

- Using only extensively reviewed data. The data collected by LLNL has been extensively reviewed by the laboratory for quality assurance. This quality assurance was performed prior to LLNL publishing a paper in Water Resources Research that used the same data. This ensures that the data used for the current project has met strict QA/QC guidelines of Lawrence Livermore Laboratory.
- Providing senior review of all techniques and results. All analyses and results will be reviewed by senior hydrogeologists or engineers. The senior hydrogeologists or engineers will review all analysis techniques, assumptions, and results to make sure the analyses are defensible, accurate, and reasonable.

Task 2: Integrate the Creek/Aquifer Interaction Results into the Olympic Valley Groundwater Flow Model

Quality assurance and quality control will be assured while updating and refining the existing groundwater model by using the following techniques:

- Using widely accepted groundwater model codes. We will use only USGS tested groundwater model codes to model Squaw Valley. The current groundwater model is developed with MODFLOW 2000 (McDonald and Harbaugh, 1988). The model will be updated to MODFLOW2005 (Harbaugh, 2005). Both of these models are well tested and widely accepted for modeling groundwater.
- Using a widely accepted graphical user interface (GUI) for error checking. The MOFLOW2005 model will be refined using the Groundwater Vistas GUI. This GUI is widely used throughout the world. It provides substantial error checking of model input files; reducing modeling errors by identifying potential mistakes before they are included in model simulations. Furthermore, GUIs provide quality checks by allowing visual review of model input and output. This visual review can identify both outliers in model inputs such as hydraulic conductivity, and unexpected model results such as unusual cones of depression.
- Following modeling best practices as outlined in standardized texts. The modeling process will follow industry standard methods, practices, and procedures such as those discussed in Applied Groundwater Modeling (Anderson and Woessner, 1992), Groundwater Flow Modeling Guideline (Murray Darling Basin Commission, 2000), and Effective Groundwater Model Calibration (Hill and Tiedeman, 2007). These texts detail industry standard approaches for model development, model calibration, and model use.
- Checking model calibration against substantial and varied groundwater data. The standard test of model calibration is to check model results against measured data. The model results will be compared to water elevation data from 41 wells in Squaw Valley. Comparisons will both be visual and statistical. Visual comparison will ensure that simulated trends in groundwater elevations match observed trends in groundwater elevations. Statistical analysis of results will compare simulated and observed groundwater elevations using mean errors, mean absolute errors, root mean squared errors, and root mean squared error divided by the range of observations. All of these statistical techniques are commonly used to quantify model accuracy, and are described

in detail by Anderson and Woessner (1992). Additionally, model results will be checked against the stream/aquifer flows calculated in Tasks 1 and 2.

- Providing senior review of all techniques and results. All techniques and results will be reviewed by senior hydrogeologists or engineers that are licensed in the State of California. The senior hydrogeologists or engineers will review all analysis techniques, assumptions, and results to make sure the groundwater model is defensible, accurate, and reasonable.

Task 3: Develop Groundwater Pumping Guidelines for Olympic Valley

Quality assurance and quality control will be assured while developing groundwater pumping guidelines by using the following techniques:

- Regular interaction with stakeholders. The draft groundwater pumping guidelines will be vetted by stakeholders that attend the GWMP advisory group. This will ensure that the pumping guidelines are acceptable to all stakeholders, and that important issues have not been excluded from the guidelines.

Task 4: Reporting

Quality assurance and quality control will be assured during all reporting activities by using the following techniques:

- Providing senior review of all techniques and results. Every report will be reviewed by at least one senior hydrogeologist or engineer that are licensed in the State of California, as well as the General Manager of Squaw Valley Public Service District. Our cost estimate specifically includes time and effort to incorporate senior review comments into our reports before they are delivered. Senior reviews address all aspects of the reports including factual accuracy, clarity of presentation, appropriate and accurate syntax and punctuation, and document formatting.

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